VOLUME 5 AUGUST, 1994

THE *SEM* INAR

The newsletter that addresses the *probing* concerns of Forensic Science

SCANNING/SEEMS '94

The combined SCANNING/SEEMS '94 meeting was held May 16 to 20 in Charleston, SC, and of particular interest was the Forensic Session on Thursday. With standing room only, it was the most attended of the many sessions. Charleston was beautiful, and the Irish music (or was it Bluegrass?) superb. If you missed this year, there will be a Forensic symposium at SCANNING '95, March 28-31, in Monterey CA .

Charles Erikson, (Research Division, Office of Laboratories and Scientific Services, U. S. Customs Service, Washington, DC). **Forensic Uses of Scanning Electron Microscopy/EDS X-Ray by the U.S. Customs Service.** Customs uses SEM to control commerce and assure border regulations. Patent infringement regarding the manufacture of an EPROM (electronically programmable read-only memory) can be determined by imaging specific features of the device by SEM. Denim finishing process (stone washed, enzyme washed) can be determined by a combination of LM and SEM. Demonstration of both cell structure in a cross section and surface morphology will permit differentiation between eelskin, leather and plastic. Particle size analysis was used to differentiate traces of heroin and cocaine.

William Dean, (Hamilton County Coroners Laboratory, Cincinnati, Ohio). **SEM/EDXA Applications in a Moderate Sized Crime Laboratory**. SEM/EDXA is routinely used to

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PEAK PERFORMANCE #2:

A Peak By Any Other Name

When you look at a typical EDS peak, iron, for argument's sake, it looks like a garden variety, normally distributed spread of data values: Why, then, is 6.4 keV given as the energy of iron? Why does a *peak* have a *single value*? If you consult the *ASTM X-Ray Emission Wavelengths and kev Tables for Nondiffractive Analysis*[1], you are confronted with pages and pages of single numbers identifying a peak, which is obviously a variety of x-ray intensities ranging from a low keV value to a high keV value. The physical response of the element is one thing; the way in which the instrumentation detects and processes it is another.

Each element yields x-rays of a characteristic energy (see Peak Performance 1). The "natural" width of an X-ray peak depends principally upon two things: its energy and the wave/particle duality of physics. Depending upon the energy of a peak, its width will range between 2-10 eV at the full width of the peak at half its maximum height [**FWHM** or "**full width half max**"].

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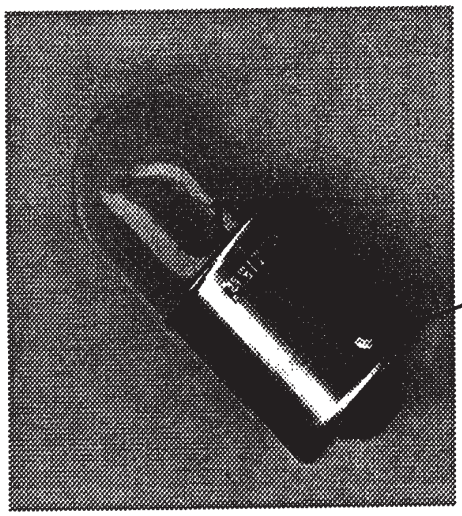
identify explosive residues in bombing cases. The presence of potassium and sulfur may indicate black powder as an explosive, while chlorine may indicate "Pyrodex". Fractures, such as wire ends from tape players pulled from automobiles, and chrome trim from hit and run accidents are matched by SEM. Bill addresses the question of relevance of trace evidence, as a sample may be too small to be representative of the original material. His scheme for the analysis of paints includes IR and SEM.

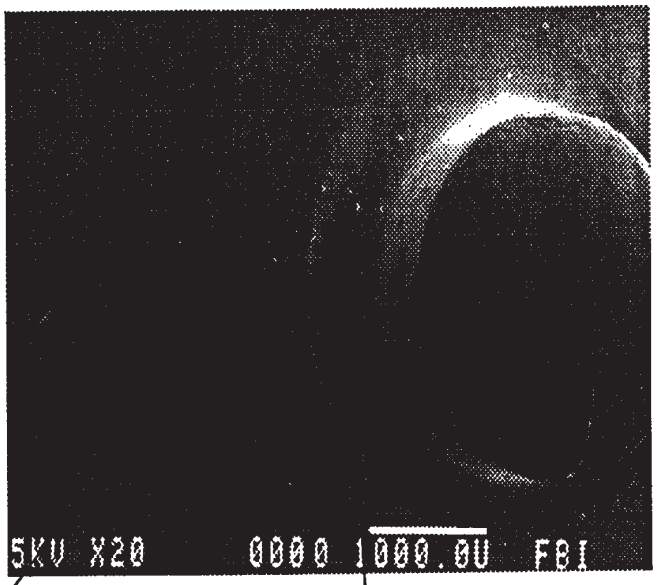
Allan Walters, (US Postal Inspection Service, Dulles VA). **Applications of SEM/EDAX in the U.S. Postal Inspection Service Forensic Laboratory**. His two main applications of SEM/EDAX are explosive residue analysis and alloy quantitation. Device components are analyzed directly in the SEM for inorganic residue analysis. This analysis provides an initial characterization of the explosive and is used as a guide for further analysis by XRD, FTIR, HPLC, TLC, and chemical spot tests. Standardless quantitative analysis is routinely performed on lock bodies, lock springs, keys and lock tumblers to determine whether these materials meet specifications. Reverse engineering of specific components of mail sorting machines is also performed using quantitative techniques.

Dennis Ward, (FBI, Washington, DC). **SEM Methods at the FBI.** A database of compositional characteristics of materials has been designed and constructed to fulfill the needs for comparison and identification of questioned materials. Standard spectra are collected and a specific peak for each element is integrated above background and ratioed to the sum of the peaks from all elements present. This value is stored in a "periodic table" database. (R-base). The standard files include metal alloys, building materials, paints, tape adhesives, household products, fingerprint powders, and cosmetics. The reference list can be queried for alloy matching, identification of an unknown material, or manufacturer identification. Additionally, a variety of other applications was presented.

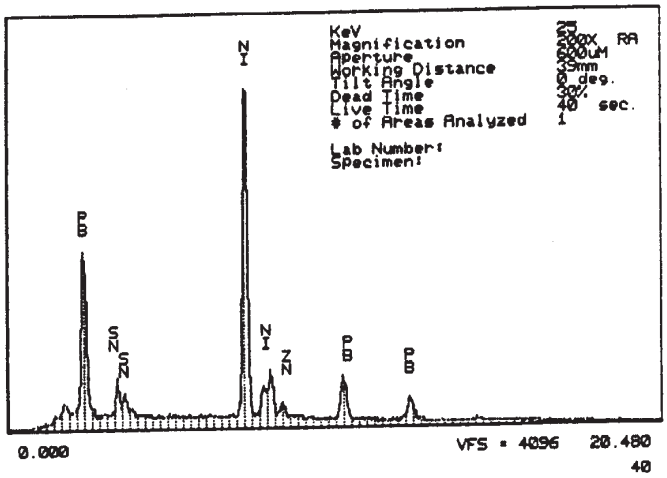
Frank Platek, FDA, Cincinnati, OH, **Forensic Scanning Electron Microscopy Related to the Pepsi "Tampering" of 1993 (and Related Food and Drug Samples)**. Frank has investigated more than 200 allegations of soft drinks contaminated with syringe needles, nails, screws, bullets, pins, sewing needles, tacks, glass, plastic shards, and rodent carcasses. Insulin syringes were examined by SEM for blood cells or tissue, and by SEM/EDXA for Zn consistent with insulin residue. Corrosion rate and appearance studies were performed (including oxygen maps) on aluminum syringe crimps to provide a basis on which to evaluate consumer complaints.

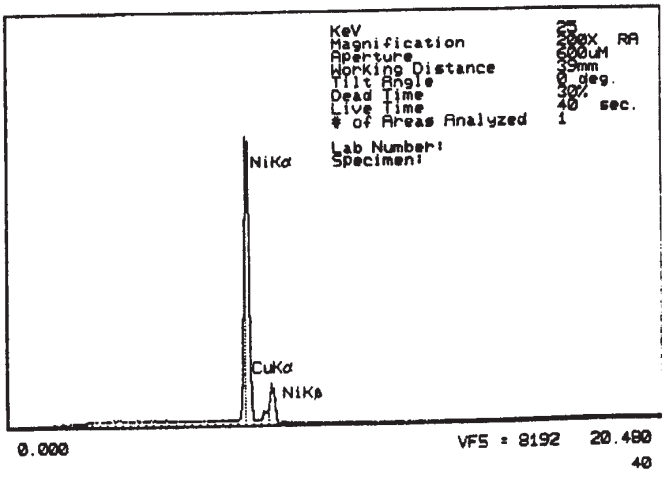


This evidence was "scanned" directly with ZSoft PhotoFinish software.



SEM photomicrograph, "scanned" into final report.





. . . Dennis Ward, Richard Rebbert, FBI

CAN YOU HELP?

Dear *SEMinar*

Recently I surveyed the SEM stubs I had available for GSR work with our Zeiss 960A. I decided that the 14mm diameter size was the most efficient for our work within the morgue. The collection area was just a bit larger than the 12.7mm diameter lifters, and the time of analysis was much less than the 3/4" stubs. Also 14mm stubs were the largest size that would fill all positions in the 16 sample stage of the microscope. Additionally it was convenient that a #8 cork borer could be used to cut out disks of carbon impregnated sheet adhesive and the disk would just cover the stub surface. The problem is that I can not find a vendor for the 14mm aluminum stubs. I believe the ones now in the lab were obtained when a previous order was filled incorrectly. A search of the stack of old SEM supply catalogs in the lab failed to uncover even a mention of 14mm stubs. Through the diligent efforts of Art Dewey at Zeiss I've discovered that a 14.3mm aluminum stub with a 3.1mm pin was once used by the AMRAY 1400 instrument. Unfortunately the supplier he suggested (EMSL in NJ) appears to be out of business. Is there anyone among the *SEMinar* readership that might know of a source for 14mm stubs with a 3.1mm pin size? The disk part of the stub is about 1 1/2 mm thick and does have a groove around the edge.

Along the same lines I'm open for suggestions on how to punch out adhesive disks to make up our own lifters. One suggestion is to put a cork borer in a drill press and punch them out. Are there any paper punches or sheetmetal punches that would be suitable? Even with small batches of a hundred lifters or so it is a bit tedious to do it totally by hand.

On a separate tack I would be interested to see in the *SEMinar* some comments by people about video microscopy and digital image processing using personal computers. Perhaps the people that have the GRIM2 refractive index measurement system could comment on whether that system is useful for general video microscopy or only for looking at glass? Can it store an image as a TIFF file so it can be processed with software other than that in GRIM2? We are considering buying a framegrabber for our OXFORD EXLII EDX spectrometer. This would allow us to digitize a video image from an optical microscope (with CCD camera) and process it with all the software presently available for the SEM image (ie. FEATURESCAN). Our document people have a DOYA infrared viewer with a standard RS-170 output. Could we connect that to the EXLII framegrabber? Why would we want to? What are the advantages I could use to justify the cost? Has anyone done such a thing? Also does anyone have any experience using the XLI corp. (1-(508)670-5999) enhancement package for the Laserjet II that upgrades the performance to 2400 DPI? I have heard that it is possible to overlay digital images with the PHOTOSHOP software. Is that true? What software is available in the public domain for digital image work?

I welcome any information or discussion on these topics.

---Bill Dean (513) 221-1133 or FAX (513) 221-0307

The Missouri State Highway Patrol Crime Lab has recently taken delivery of a Hitachi 2460-N Environmental SEM with an EDAX DX-4. Non-conductive, non-coated specimens can be imaged at high (25 kV) accelerating voltages allowing for X-ray analysis. William Randle of the lab promises to keep us informed as unique applications arise. He would like to know what unique applications others have found using environmental SEM's. Any considerations you have can be addressed to Will at the Missouri State Highway Patrol, 1510 E. Elm Street, Jefferson City, MO 65101 or phone 314-526-6134.

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FWHM in eV is the standard descriptor for peak resolution. The other part of this width is due to the photon energies for a single peak having a statistical distribution even though the electron transitions in that element's atoms are identical. Put metaphorically, if 10 people purchase the same 5 items at 10 different grocery stores, you would expect the final sales total to vary due to pricing differences, state or local taxes, etc. This variation is the result of [**Heisenberg's Uncertainty Principle**], which states that it is impossible to determine with accuracy both the position and the momentum of a particle simultaneously. The more accurately the particle's position is known, the less accurately its momentum (for our purposes, read "energy") can be determined. Because particles are also waves, we have to live with this sort of thing.

When the signal arrives at the EDS system, it is degraded even further; EDS manufacturers tend to spend most of their electronics R&D time attempting to reduce this loss of peak resolution. The measured peak width from the EDS detector is degraded by the combination of the way the detector system responds and processes the incoming photons and the natural line width. As an example, the manganese Kα peak is listed at 5.898 keV, with a FWHM of the natural peak of 2.3 eV. Once detected and processed, however, this peak can broaden out to 130-150 eV FWHM, depending on the quality of the detector.

This is because, first, when monoenergetic photons (that is, all from the same element) enter a detector, each photon does not necessarily have all of its energy channeled into a useable, characteristic signal; those that do are called [**charge carriers**]. Instead, some are charge carriers and others are lost or converted into spectral artifacts (another topic!); the number of photons that do become charge carriers display a statistical distribution, which adds to the peak width. Second, as with all electronic amplification systems, thermal noise is added to the signal of interest and also broadens the peak.

For any given x-ray peak above 1.0 keV, the distribution of charge carriers, which is Gaussian in its shape, for a single photon energy Y is described by:

$$Y = A_A \exp\left[-1/2\left(\frac{E_A - E}{\sigma}\right)^2\right]$$

where A_A is the maximum x-ray intensity, E_A is peak energy and E is x-ray energy; this relationship is shown graphically in Figure 1.

For the analysts out there who may be surprised to see the statistic [**standard deviation** or **σ**], which is a measure of the scatter of a series of measurements about their average value, incorporated into the above formula, I can only say, "Just wait". Statistics is an important part of spectroscopy and is as important, if not more so, as the chemistry. Understanding how an EDS detector works is fairly straight forward chemistry and physics; understanding the numbers the printer spits out requires all of that knowledge *and* a solid grounding in statistics. As a basic example, to define a peak as being such, a range of x-ray photon charges must be greater than 3 times the standard deviation of the background signal. In doing so, you must measure the charges, calculate a [**mean**] (the sum of a set of measurements divided by the number of measurements) and then calculate the standard deviation for that range of energies. You can't escape it[2].

Therefore, to look at peak broadening as the standard deviation from the natural x-ray peak (read, "mean") we can say that the FWHM is equal to (2.355 x σ). As mentioned previously, noise comprises a large portion of the peak but even if noise were completely removed from the system, the theoretical energy resolution of Fe Kα would be about 100 eV. An instrument parameter that affects the width of peaks is the [**time constant**], the setting which determines the amount of time each photon's charge is measured. The time constant is typically incremented in is (10, 20, 40, etc.) or as a dimensionless number simply indicating a shorter or longer measuring time. The analyst should choose a time constant that is appropriate for the sample and analysis. For example, when working on paint samples that must be quantified to be distinguished, a LONG time

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constant is desirable, since each pulse will be measured and placed into the spectrum as accurately as possible, optimizing for peak resolution. For GSR work, however, a shorter time constant is applied, since I'm not so concerned about accuracy to a few weight percents as I am getting as many counts per particle in as short a time as possible. For "typical" samples (yeah, right), a medium time constant which balances resolution with count rate is best. Time constant is a knob because it *can* and ***should*** be changed; I have walked into many analytical laboratories where the time constant was exactly as the service engineer had left it at installation. Figure 2 shows increasing peak width with increasing time constant settings.

You may ask, "What's the big deal?" when confronted with two detectors, one at 150 eV and one at 130 eV. As Figure 2 shows, the width of the peak narrows greatly as resolution improves (that is, FWHM decreases). Narrower peaks mean more accurate calculations for peak seeking routines, peak overlap corrections and quantitation as well as decreasing the minimum detection limit for low quantity elements.

Unless someone has a better idea, next time we'll talk about analog-to-digital converters, dead time, live time and real time. It'll be interesting, trust me. Remember, if you have any questions or would like to suggest topics for me to address, please fax me (Max M. Houck) at (817) 927-0902.

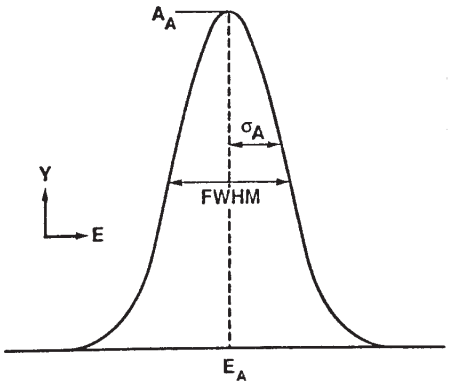

Figure 1: Gaussian peak shape representation for x-ray peaks above 1 keV (from Goldstein, et al., 1992, Figure 5.34).

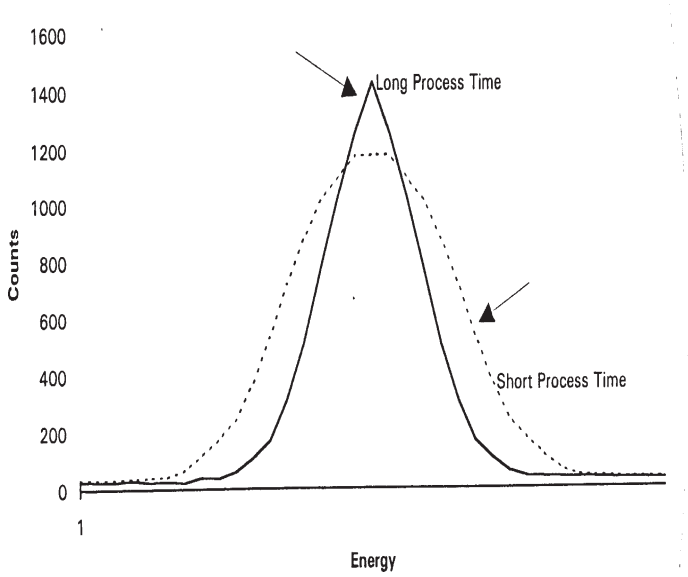

Figure 2: Ni Kα peak widths for various detector resolutions.

[1] Johnson, Jr., G.G and White, E.W., *ASTM Data Series DS 46*, 1985. ASTM, 1916 Race Street, Philadelphia, PA, 19103.
[2] You can, however, make it more palatable. I have found *Statistics in Spectroscopy* by Howard Mark and Jerry Workman (1991) to be invaluable and entertaining.

PEOPLE

Charles Midkiff has compiled a bibliography on the detection of firearms residues, covering published and presented papers using a variety of analytical methods over the past five years. Anyone interested in receiving a copy should contact Charles at National Laboratory Center, Bureau of Alcohol Tobaccco and Firearms, 1401 Research Boulevard, Rockville, MD 20850.

Tammy Jergovich, from the Tallahassee Crime Lab, Florida, has recently accepted a position at the Georgia Bureau of investigation. Her primary responsibility will be paint and polymer analysis.

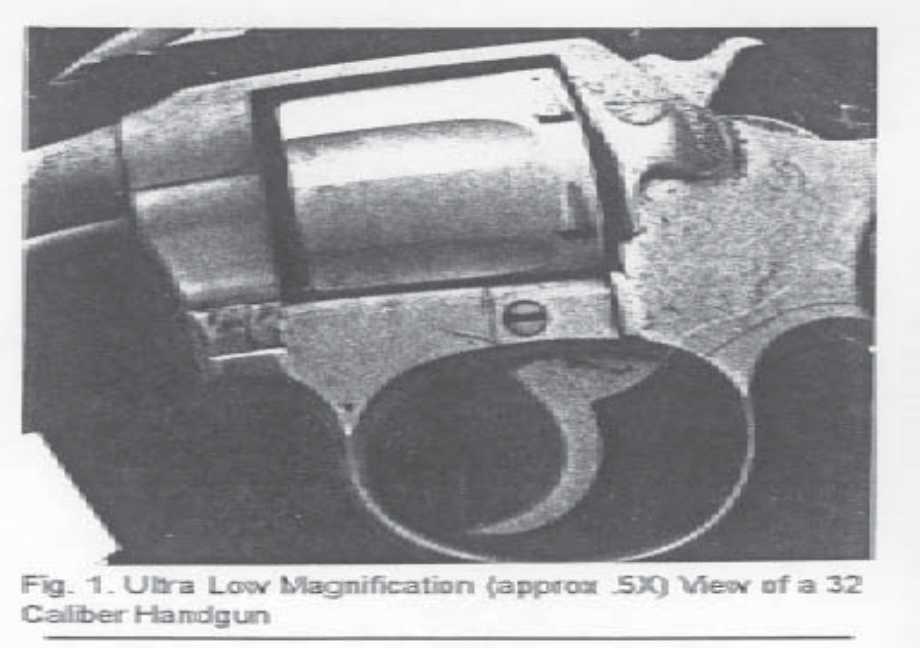

Fig. 1. Ultra Low Magnification (approx .5X) View of a 32 Caliber Handgun

JEOL Macroscope

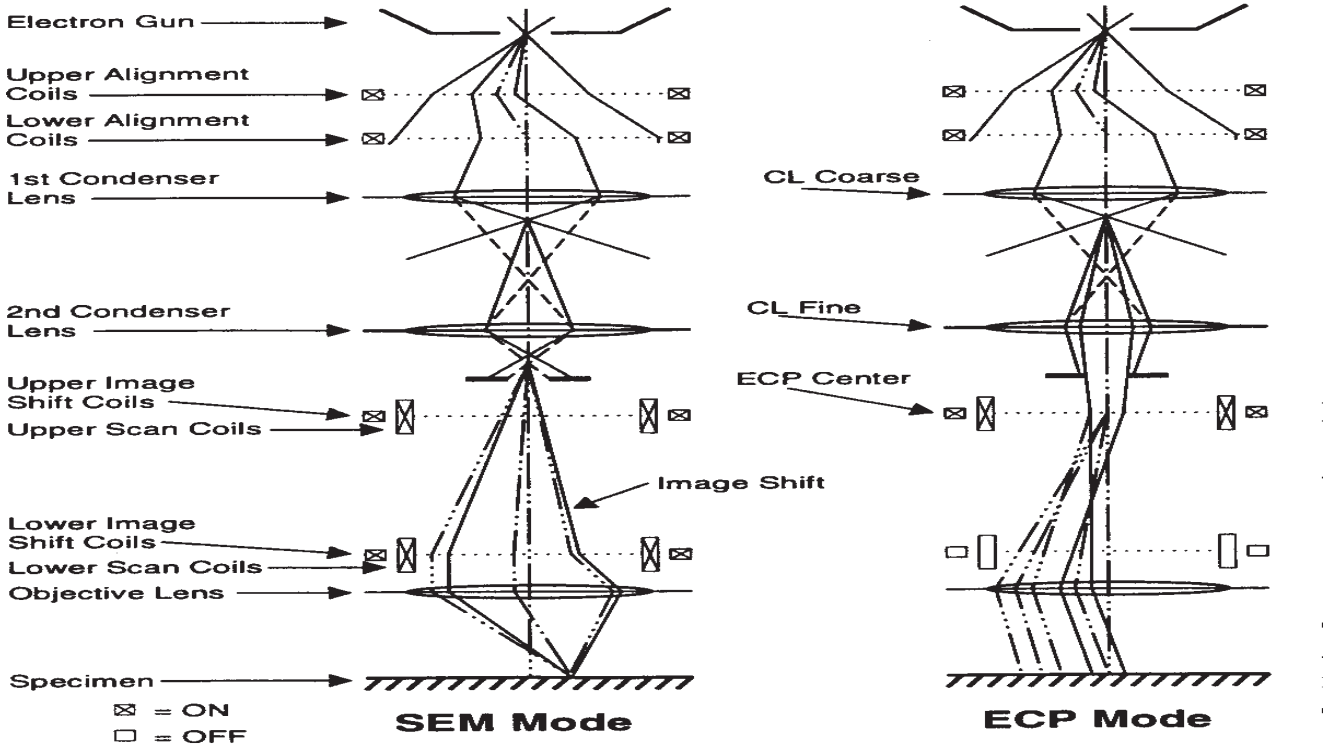

Fig. 2. Schematic Ray Diagrams

A STUDY OF PLUME CONCENTRATIONS FROM THE DISCHARGE OF WEAPONS COMMONLY USED IN THE UNITED STATES

A. J. Schwoeble, W. H. Powers, Sr.
RJ Lee Group

The authors visited several law enforcement agencies and crime labs around the U.S. to gain knowledge and information first hand on the sampling technology and analytical techniques utilized by the experts in the field related to gunshot residue (GSR).

A review of sampling protocols practiced by various agencies in the United States prompted the present ongoing study of plume concentrations from the discharge of hand guns, rifles and shotguns. The overall objective is to show the areas with the greatest potential for the collection of GSR under normal firing conditions. All test firings were recorded with a high-speed motion analyzer at 500 frames per second. A new glove was used for each test firing, removed immediately and bagged for particulate sample collection. The particulates will be examined by computer-controlled scanning electron microscopy in the third phase of this program, which is described later in this article.

Weapons selected for this study and a brief history of each weapon with the illustration objectives are available upon request.

Summary of Results

Smaller-caliber semi-automatic handguns with high or forward cartridge ejection have plume concentrations toward the front of the fingers—in some instances, heavier than web and wrist areas. In most cases, the plume tends to follow the direction of cartridge ejection. Larger-caliber revolvers have a widespread plume as opposed to the more compact plume of larger-caliber semi-automatic weapons with ejection ports.

The most consistent area of plume concentration for rifles and shotguns is the crook of the support arm; however, blow-back or drift of the original plume formation is toward the chest, shoulder, face and hair with heavy concentrations for some weapons and light in others. Again, cartridge ejection is a factor in many of these weapons.

A thirty-one minute videotape was produced from the test firings which shows slow-motion plume development for each weapon. The distribution of potential GSR concentrations from these tests may indicate larger areas to be sampled than present sampling protocols require.

This study is part of a three-phase program initiated through the cooperation and feedback from experts directly concerned with trace evidence, not only related to GSR, but in several other areas that are affected by economical and caseload priorities. An effort was made to include the most common weapons used in the U.S. The videotape was first shown at the 46th Annual Meeting of the American Academy of Forensic Sciences, February 14-19, 1994, in San Antonio, Texas, where suggestions were made for other handgun types to be studied in this manner. The authors intend to continue the production of an atlas of plume concentrations for as many weapons as are made available.

Phase II deals with improvements in sampling technology and the advancements made in the collection of GSR over large areas of skin, clothing and other material surfaces.

Phase III provides for further development of an affordable scanning electron microscope system with applications that yield rapid, multiple GSR analyses with features that provide for unattended automated analysis with electronic and hard-copy output of digital images, spectra and compositional data with immediate relocation of potential GSR particles (within 10 seconds). A Personal SEM™ with the GSR application is presently being used at RJ Lee Group to analyze samples submitted by law enforcement agencies. Interest in this program, thus far, has been encouraging and any suggestions or further input from the forensic community would be greatly appreciated.

WORTH READING!

SEM

Environmental SEM: Principles and Applications, R.E. Cameron, *USA Microscopy and Analysis*, May, 1994, 17-19.

Explains the construction and principles of operation of the ESEM, applications from a range of disciplines, and limitations of the technique.

XRF

Lowering the Limits of Detection of X-ray Fluorescence Analysis in the Electron Microscope, A. Barna, I. Pozsgai, C. Fiori, S Wight, *X-ray Spectrometry*, Vol 23, 32-35 (1994).

An XRF attachment (Mo and Ge foil) to an SEM with an energy dispersive x-ray spectrometer is described with detection limits of between 0.5 and 5 ppm on an SRM 612 glass standard.

Forensic Characteristics of Colored Polyethylene Bags, Yoran Nir-El, *Journal of Forensic Sciences*, Vol 39, No 3, May 1994, p 758-768.

The inorganic elemental profiles of colored polyethylene bags were determined by XRF, including homogeneity in single bags and reproducibility of composition within batches.

FORENSIC PATHOLOGY

The Diagnosis of Drowning by Quantitative and Qualitative Diatom Analysis, JV Pachar, JM Cameron, *Medicine, Science, and the Law*, 1993, Vol 33, No 4.

Evaluates diatom analysis in the diagnosis of drowning. Controls include samples from non-drowning deaths. Samples were prepared from tissues digested in nitric acid. Quantitative assessment was performed by LM and qualitative assessment by SEM. Method suggested supports a conclusion of death due to drowning in approximately one-third of the bodies found in water. It is suggested that the present analysis be used as a basic criteria for standardardization of the diatom method.

SEM Analysis of Incinerated Teeth As an Aid to Positive Identification, Scott I. Fairgrieve, *Journal of Forensic Sciences,* Vol 39, No 2, March 1994, p 557-565.

Identification of striations from dental restoration to aid in identification of tooth fragments.

CONCERNING A NEW METHOD FOR SECURING GUNSHOT RESIDUES FROM SHOOTERS' HANDS, Joachim Merkel and Renate Mailänder, *Archiv für Kriminologie*, 1993 191/5-6 (139-150)

A method is presented for demonstrating the distribution of Gunshot Primer Residues on the hand, to more effectively discern whether an individual fired a weapon and the type of weapon fired. A solution of polyvinyl alcohol (PVA) is applied to the hand, dried, and removed. Residues lifted in the film are color developed with sodium rhodizonate and marked on a "smoke chart" of particle distribution. Particles as small as 5 μm can be seen by this method.

Contact THE *SEM*INAR for an English translation of this paper.

Dipl. Phys. Joachim Merkel, c/o Kriminaltechnisches Institut, Landeskriminalamt Baden-Württemberg, Postfach 50 07 29, Taubenheimstraße 85, D-7000 Stuttgart 50

RADIOPAQUE DEPOSITS SURROUNDING A CONTACT SMALL-CALIBER GUNSHOT WOUND, Patrick Lantz, W. Gray Jerome, Janelle Jaworski, *The American Journal of Forensic Medicine and Pathology*, 15(1):10-13, 1994.

Radiographs of a small-caliber contact gunshot wound demonstrated significant circumscribing radiopaque material. X-ray microanalysis of the paraffin embedded entrance wound demonstrated that lead comprises most of this material. Deposits identified in this manner may prove useful in suspected contact and near-contact wounds, especially when non-jacketed ammunition has been used.

GSR PARTICLES FORMED BY USING AMMUNITION THAT HAVE MERCURY FULMINATE BASED PRIMERS, **Arie Zeichner** and Nadav Levin, *Adv. Anal. Detect. Explos, Proc. Int. Symp, 4th* 1992 (Pub 1993), 109-16.

Ammunition containing primers with mercury fulminate are manufactured by Eastern Bloc countries and used frequently in the Middle East. When ammunition having this primer is fired, residue particles containing mercury occur in the vicinity of the shooter more frequently than in the cartridge case. In a specific case, particles from Russian and Egyptian 7.62mm ammunition consisted of Sn, Sb, Hg, S, K, Cl, and Cu, with small amounts of Al, Si, Fe, and Zn, and questioned nearby clothing contained residues similar in composition but without Hg.

In order to determine whether elevated ignition temperature evaporated elemental Hg, test cartridges that were heated to 360 degrees centigrade were found to contain significantly fewer Hg containing particles.

In order to determine whether evaporation of elemental mercury can occur during micro-analysis, Hg containing particles were re-examined after 16 hours of vacuum and 1 hour of electron bombardment, with no resulting loss of mercury.

Arie Zeichner, Israel Police Headquarters, Division of Criminal Identification, Toolmarks and Materials Laboratory, Jerusalem, Israel (2) 287-111.

GRESHAM LION ACQUIRES CAMSCAN

The acquisition of Cambridge Scanning Company, Ltd. (CamScan) by Gresham Lion Technology Ltd. was formally announced at the August 1994 meeting of MSA/MAS in New Orleans.

The new company, to be called Gresham-CamScan, has been established as a division of Gresham Lion Technology, and will continue to operate from the existing CamScan premises in Bar Hill, England. Many of the original CamScan staff have joined Gresham-CamScan and will continue to develop and support the CamScan range of scanning electron microscopes.

Gresham-CamScan will be headed by Jay Bailey, former MD of Oxford Analytical Instruments Ltd. and Sales Director of Link Analytical Ltd. Also included in the management team are Barry Drayton, founder of CamScan, Malcolm Tye, Dr. Richard Paden, and Bill Key.

Instrument sales and service support in the USA will continue to be handled by CamScan USA Inc. CamScan USA is headquartered in Cranberry Twp. (Pittsburgh), Pa., and has supported the sales and service of CamScan products in the USA since 1988.

For further information, please contact:

CamScan USA: Tony Owens, Vice President 412 772-7433

Gresham-Camscan: Jay Bailey, General Manager 0628 524001

FIBER ANALYSIS ...

In an attempt to define the utility of SEM examination to determine the mechanism by which a fiber or textile was damaged, William R. Pelton, of the University of Manitoba, has submitted three papers for publication:

Distinguishing the Cause of Textile Fiber Damage Using the Scanning Electron Microscope (SEM). William Pelton. This paper recreates fabric damage under known conditions, characterizes cut end structure, and attempts to compare the appearance characteristics with known theory. The results are not consistent with studies previously published, and demonstrates overlapping characteristics for scissor cut, knife cut, and torn fabric ends. This paper demonstrates a need for further experimentation to establish reliability of the method. (submitted to the Journal of Forensic Sciences)

Part I -- Using the Scanning Electron Microscope to Identify the Cause of Fibre Damage: A Review of Related Literature . Pauline Ukpabi, William Pelton. In an attempt to outline known theory explaining fiber end appearances, the authors critically reviewed published information in forensic investigations and court proceedings as well theories for single fiber fracture/failure established by textile scientists. The review suggests comparative studies between single fiber damage and fabric damage analyses, and a need for collaborative studies between textile and forensic scientists. (submitted to the Canadian Society of Forensic Science Journal)

Part II -- Using the Scanning Electron Microscope to Identify the Cause of Fibre Damage: An Exploratory Study William Pelton, Pauline Ukpabi. A pilot study was conducted to determine the capability of the SEM technique to distinguish cuts from tears or to identify the particular mechanism used to damage a fabric by simply looking at the fiber end appearance. The results of the study showed that the recognition probability of correctly identifying the cause of damage was low and fiber ends created by different damage mechanisms showed overlapping characteristics. A need for more extensive, systematic and collaborative work in this area exists and scientists need to exercise caution in using the SEM technique to identify the cause of fabric damage in criminal investigations. (submitted to the Canadian Society of Forensic Science Journal)

address for correspondence:

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note: William Pelton has been invited to present a paper at the Forensic Science Session of SCANNING 95 (see ad on page 4)

EVALUATION OF CORROSION EXPOSURE OF METAL USING THE SCANNING ELECTRON MICROSCOPE

Customs Laboratory Bulletin
Volume 5, Number 4, October 1993
Lourdes D. Dabu, Los Angeles Customs Laboratory

In an attempt to determine the length of time a metal box (determined to be a low-alloy steel by SEM-EDXA) used to smuggle controlled substances was submerged, a method was developed to determine the length of time the box was in contact with water by estimating the rate of corrosion.

I. *Determine thickness of corrosion*

The thickness of corosion is estimated by direct measurement of the layer in a cross section by SEM.

II. *Determine rate of corrosion*

The rate of corrosion is determined by exposing a clean blank of the box metal of known area and weight to similar sea water corrosion conditions. After several days of exposure the contamination is removed without the base metal being disturbed. The weight difference equals the mass loss due to corrosion, and is used to determine the rate of corrosion by the calculation:

corrosion rate = (K x W)/(A x T x D) where:

K = a constant, listed in ASTM G1-90, section 8.1.2
W = time of exposure
A = area
T = mass loss
D = density

III. *Estimation of submersion time*

The estimated submersion time equals the corrosion thickness divided by the corrosion rate.

for a reprint of the original article, contact:
***Lourdes D. Dabu**, Customs Laboratory, 300 S. Ferry St, Terminal Island, Rm 2503, San Pedro, CA 90731. 310/514-6184.*

EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT METEORITES, BUT WERE AFRAID TO ASK, **Marianne Stam**, DOJ Riverside, CA. Tie-Line, Vol 18, #1, California Department of Justice.

The “rock” that crashed through the house window - was it thrown? or did it result from a recent meteor shower? In very general terms, the most commonly occurring meteorites have the following characteristics: contain minor amounts of nickel (but more than usually found in terrestrial rocks), contain less calcium that iron, are highly magnetic, quite dense, and have a notable black smooth “fusion crust”, formed from surface melt as it falls through the atmosphere. Since the questioned “rock” had few of these characteristics, the conclusion was that it was not a meteorite, and was probably steel mill slag.

MEETINGS, SCHOOLS . . .

(August 1994)

Denver X-ray Conference, August 1-5, 1994, Steamboat Springs, CO. Lynne Bonno, Dept of Engineering, U of Denver, Denver, CO 80208.

September 1994

Micro94, Sept 12-15, 1994, London, England. Royal Microscopical Society, Tel: (0865) 248768

October 1994

SEM and X-Ray Microanalysis for Materials Science: An Introductory Course, Oct 10-14, 1994. State University of New York at New Paltz. 914/257-3800.

Midwestern Association of Forensic Scientists (MAFS),Oct 11-16, 1994, Cleveland, OH. Mary Wenderoth or Cathy Denissoff, 216/623-5646.

Northeastern Association of Forensic Scientists (NEAFS), Oct 13-15, 1994, New York City, NY. Jeffery Luber 516/853-5585.

California Association of Criminalists (CAC), Fall Seminar, Oct 19-22, 1994, Pasadena, CA. Contact Manuel Munoz or Dan Anderson, Los Angeles County Coroner, 213/343-0530. (This will be the first joint CAC/Forensic Science Society meeting!)

Canadian Society of Forensic Science (CSFS) and Northwest Association of Forensic Scientists (NWAFS), October 31-November 5, 1994, Vancouver, British Columbia, Canada. Jeffrey Coughlin, 604/264-3507.

November 1994

Advanced Materials, Nov 7-10 (Tucson, AZ). Institute for Microstructural Analysis, Buehler Ltd, Lake Bluff, IL. Preparation and characterization techniques for microscopic analysis, including SEM. 708/295-4659.

Australia and New Zealand Forensic Science Society, November 21-25, 1994, Auckland, New Zealand. Douglas Elliot, Auckland, New Zealand, 09-815-3670.

Southwestern Association of Forensic Scientists (SWAFS) will hold its Fall 1994 training seminar at the Adam's Mark Hotel in Houston, TX, Nov 15-19, 1994. A variety of workshops. Pauline Louie, Houston Police, 713/247-5449

March 1995

SCANNING '95, *FORENSIC SCIENCE SESSION*, March 28-31, 1995, Doubletree Hotel, Monterey, CA. Mary Sullivan, 201/818-1010.

May 1995

California Association of Criminalists 85th Semi-Annual Meeting, May 10-13, Walnut Creek Marriott in Walnut Creek, CA. Karen Sheldon, 510/646-2455.

MAS 1995, Denver, CO
MSA 1995 August 13-18 Kansas City, KS
MAS/MSA 1996, Minneapolis

PUBLICATION POLICY

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